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Dynamic Analysis of Korean Nuclear Fuel Cycle with Fast Reactor System

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본 보고서를 2004 년도 “건식 재가공 핵연료 노심특성 평가 기술개발” 과제의 기술 보고서로 제출합니다.

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ABSTRACT

The Korean nuclear fuel cycle scenario was analyzed by the dynamic analysis method, including Pressurized Water Reactor (PWR), Canadian Deuterium Uranium (CANDU) and fast reactor systems. For the once-through fuel cycle model, the existing nuclear power plant construction plan was considered up to 2016, while the nuclear demand growth rate from the year 2016 was assumed to be 1%. After setting up the once-through fuel cycle model, the Korea Advanced Liquid Metal Reactor (KALIMER) scenario was modeled to investigate the fuel cycle parameters. For the analysis of the fast reactor fuel cycle, both KAILMER-150 and KALIMER-600 reactors were considered. In this analysis, the spent fuel inventory as well as the amount of plutonium, minor actinides (MA) and fission products (FP) of the recycling fuel cycle was estimated and compared to that of the once-through fuel cycle.

Results of the once-through fuel cycle calculation showed that the demand grows up to 64 GWe and total amount of spent fuel would be ~102 kt in 2100. If the KALIMER scenario is implemented, the total spent fuel inventory can be reduced by ~80%. However it was found that the KALIMER scenario does not contribute to reduce the amount of MA and FP, which is important when designing a repository. For the further destruction of MA, an actinide burner can be considered in the future nuclear fuel cycle.

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I. Introduction

There are many factors that should be considered when determining the national nuclear fuel cycle model. Currently only the thermal reactors such as Pressurized Water Reactor (PWR) and Canadian Deuterium Uranium (CANDU) reactor are being commercially operated in Korea. The near-term deployment plan of the nuclear power plant also includes only PWR. However the Generation-IV nuclear system is very actively studied over the world to develop innovative nuclear systems that can be implemented in 2030. For example, sodium-cooled fast reactor (SFR), lead-cooled fast reactor (LFR), gas-cooled fast reactor (GFR), molten-salt reactor (MSR), supercritical water reactor (SCWR) and very high temperature reactor (VHTR) are being developed as candidate reactors for the next generation.

Most of these Generation-IV [1] fast reactor systems consider recycling of spent fuel as the optimum fuel cycle option in order to reduce the spent fuel accumulation. In Korea, the SFR is being developed in parallel with the Generation-IV program, which can contribute to establish a new fuel cycle model in the future. It is also known that the benefit of having fast reactor systems could be degraded if the deployment time is not appropriately determined. Therefore it is recommended to quantitatively estimate the amount of spent fuel produced from the proposed fuel cycle. Such estimation should be done in the time domain so that the effect of deployment time of the fast (or new) reactor system is visualized.

In this study, the Korean nuclear fuel cycle scenario is analyzed based on postulated fast reactor fuel cycle. This study estimates the spent fuel inventory as well as the amount of other important nuclear materials. The results of this study will provide important data for the design analysis of the repository and selection of reactor strategy in the future. First, the once-through fuel cycle was analyzed as the reference case in Chapter II. Second, postulated fast reactor fuel cycles are analyzed and the results are compared to those of the once-through fuel cycle calculation in Chapter III. Finally, Summary and conclusion are given in Chapter IV.

II. Once-Through Fuel Cycle

Before analyzing the Korean fast nuclear reactor scenario, the once-through fuel cycle was set as the reference case and the dynamic analysis was performed by a dynamic analysis code DYMOND [1, 2]. The DYMOND code employs the “ITHINK” platform [3] to assess the long term fuel cycle scenario. In the DYMOND, it is assumed that the reactor system evolves over time. Based on the energy demand model, the reactor and fuel cycle scenario such as the number of reactor to be built, operating reactor and capacity of each reactor type can be determined. Through time-evolving analysis of the candidate fuel cycles, the most appropriate fuel cycle can be chosen, considering the technical and economic impacts over time.

During the current century, the nuclear power was assumed to grow from 13.716 GWe in 1999 to 27.32 GWe in 2015 [4]. From the year 2016 to the year 2100, the growth rate was assumed to be 1%. For the reactor information of the once-through fuel cycle, current operating reactors are considered which are 12 PWR and 4 PHWR. The reactor life time was assumed to be 40 yrs for both the PWR and PHWR. The specifications of the PWR are shown in Figs. 1 and 2, while those of the PHWR data are shown in Figs. 3 and 4. In this scenario, all of the PHWR were assume to be shutdown after its life time and there will be no more PHWR construction.

Figure 5 shows the nuclear demand variation with time. In 2100, the demand is expected to be 63.7 GWe. Figures 6 and 7 show the deployment of fuel cycle services and reactor needed to meet the energy demand. The deployed capacity which is determined by the capacity fraction of each reactor type varies with the demand, but it is not exactly the same as demand because an already deployed reactor capacity does not exactly match to the demand curve. Once all PHWRs are shutdown, the electricity generation is dominated by PWR after 2040. The number of operating PWR in 2100 is expected to be ~48 for the reactor power of 1.4 GWe. As shown in Fig. 8, the number of PWR to be built or ordering is also varied with the deployed capacity, because the number of reactor to be ordered per year should be determined to maintain total reactor capacity.

Figures 9 to 11 show the amount of spent fuel (SF), uranium (U), plutonium (Pu) and minor actinides (MA). The SF inventory gradually increases with time, and the total SF will be 102.2 kt in 2100. After 2049, the PHWR SF remains constant at the value of ~17 kt because no more spent fuels are produce from the PHWR. The total amount of U, Pu and MA in SF will be 95.6 kt, 1.2 kt and 0.13 kt, respectively. As shown in Fig. 12, the total amount of FP in the SF will be 5.3 kt in 2100.

III. Fast Reactor Scenario

In Korea, the Korea Advanced Liquid Metal Reactor (KALIMER) [5-7] has been developed since 1992, which is a pool-type sodium-cooled fast reactor. The KALIMER was designed by two concepts: KALIMER-150 [5] with a breeding ratio of 1.05 and 150 MWe and KALIMER-600 [6,7] with a breeding ratio of 1.0 and 600 MWe. The core configurations of each KALIMER system are shown in Figs. 13 and 14, respectively.

In this study, a symbiotic fuel cycle between once-through power plant and KALIMER has been analyzed. Important fuel cycle parameters such as the amount of spent fuel (SF) and the corresponding plutonium, minor actinides (MA) and fission products (FP) inventories are investigated and compared with those of the once-through fuel cycle. In the FR fuel cycle analysis, it was assumed that the new fast reactor (FR) is constructed from 2015. In order to feed the FR, it was also assumed that the PWR SF is reprocessed from 2010, and the FR SF reprocessing begins in 2020. The FR capacity with time is shown Table I, and the FR fuel composition data are shown in Figs. 15 and 16.

III.1 KALIMER-150 Scenario

Figure 17 shows the deployment of fuel cycle services and reactor needed to meet energy demand. The demand and deployed capacity are almost the same as those of the once-through case. Beyond 2030, the PWR sharing of the capacity deceases, ultimately reaching ~80% in the year 2100, while the remaining KALIMER-150 capacity increases to ~20% in the year 2100. As shown in Fig. 18, the numbers of operating PWR and KALIMER-150 reactor increase and become ~40 and ~73 in the year 2100, respectively. Figure 19 indicates that the number of ordering PWR and KALIMER-150 reactor vary with the deployed capacity.

Figures 20 - 22 give the amount of the SF, U, PU and MA in the SF. Beyond the year 2015, the PWR SF decreases with time and goes to ~0 kt, while the PHWR SF dominates whole the century. This is because both PWR and FR SF are reprocessed and recycled in the

FR. The total SF will be ~17 kt in the year 2100. The total amount of U, Pu and MA will be 17.2 kt, 0.7 kt and 0.13 kt, respectively. In the FR scenario, there is burned U after reprocessing. The amount of burned U in 2100 is expected to be 72.4 kt. In Fig. 23, it can be seen that the total amount of FP will be 5.16 kt .

III.2 KALIMER-600 Scenario

Figure 24 shows that the deployed capacity of the KALIMER-600 scenario is almost the same as that of the KALIMER-150 scenario. While, as shown in Fig. 25, the number of KALIMER-600 reactor is ~18 in the year 2100. The number of KALIMER-600 ordering shown in Fig. 26 decreases to 1/4 of that of the KALIMER-150.

Figures 27 - 29 show the amount of the SF, U, PU and MA in the SF. Like the KALIMER-150 scenario, the PWR SF decreases with time and goes down to ~0 kt, while the PHWR SF dominates the whole century after 2015. The total amount of U, Pu and MA will be 17.2 kt, 0.87 kt and 0.11 kt, respectively. The amount of burned U in the year 2100 is expected to be 72.6 kt. The total amount of FP will be 5.16 kt, which is shown in Fig. 30.

III.3 Comparison of KALIMER Scenarios with Once-Through Scenario

The amount of SF is compared in Table II and Fig. 31, which shows drastic decreases of the SF for both KALIMER scenarios. As shown in Table II and Fig. 32, the amount of U varies with the same trend as that of the SF. For the amount of Pu shown in Table II and Fig. 33, it is known that KALIMER-150 and KALIMER-600 can reduce the Pu amount by 33% and 29%, respectively. As compared in Figs. 34 and 35, however, the KALIMER scenario does not contribute to reduce the amount of MA and FP.

IV. Summary and Conclusion

The Korean fast nuclear reactor cycles have been investigated. After setting up the once-through model, FR scenarios were analyzed from viewpoints of spent fuel and heavy element inventories.

From the once-through scenario, it can be summarized as follows:

- The demand grows up to 63.7 GWe in the year 2100.
- The total SF and U in SF are 102.2 kt and 95.6 kt in the year 2100, respectively.
- The amount of Pu, MA and FP in SF are 1.2 kt, 0.13 kt and 5.3 kt in the year 2100, respectively.

From the FR scenarios, it can be summarized as follows:

- The amount of total SF is reduced by 83% by both KALIMER scenarios compared with the once-through scenario.
- The two KALIMER scenarios can reduce the amount of Pu by 33% and 29% compared with the once-through scenario.
- Both KALIMER scenarios slightly reduce the amount of MA and FP.

From the above results, it was found that the KALIMER scenario does not contribute to a reduction in the amount of MA and FP, which is important when designing a repository. For a further destruction of MA, an actinide burner can be considered in the future fuel cycle.

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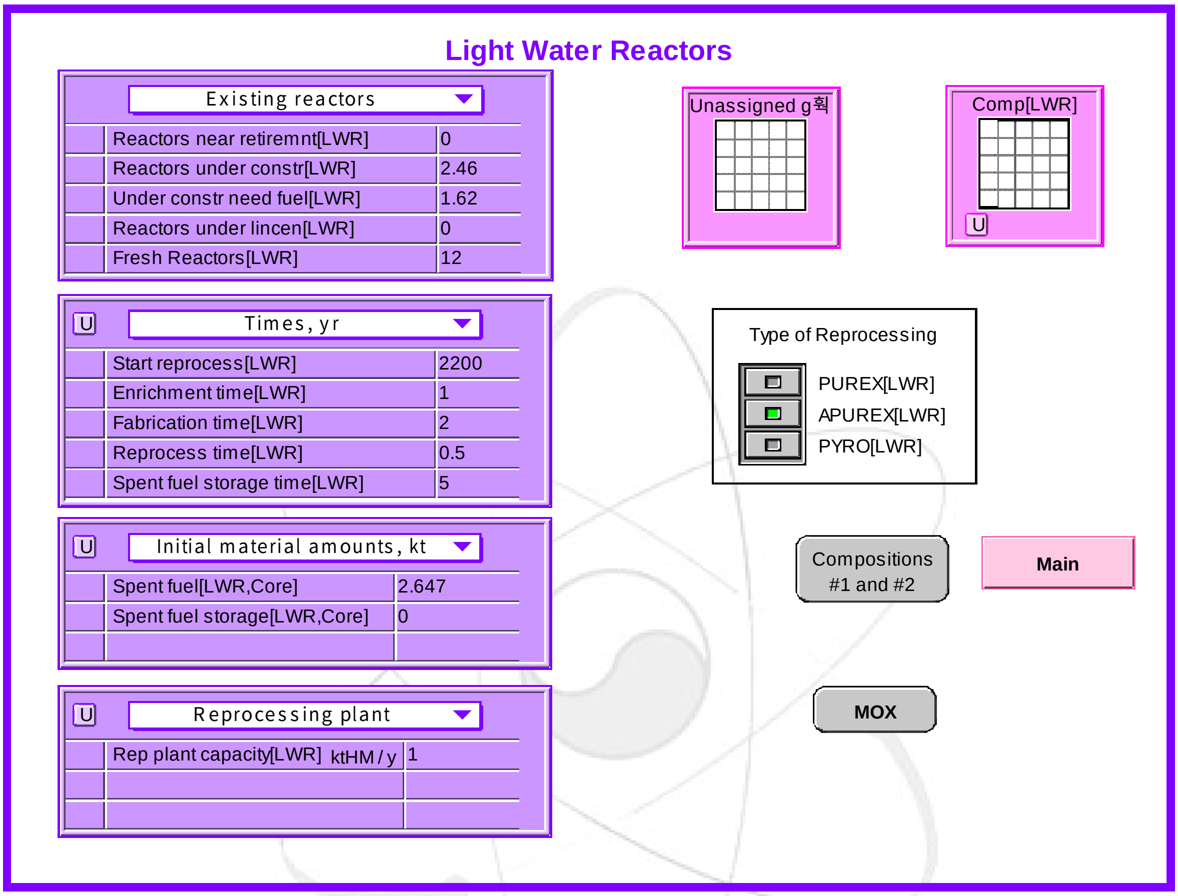
Table I Fast Reactor Capacity with Time

Time	FR Capacity (%)
2000	0
2005	0
2010	0
2015	5
2020	5
2025	5
2030	5
2035	5
2040	10
2045	10
2050	15
2055	15
2060	15
2065	15
2070	15
2075	15
2080	15
2085	15
2090	15
2095	15
2100	15

Table II Comparison of Spent Fuel and Heavy Element Inventory (kt)

	Once-through	KALIMER-150	KALIMER-600
PWR SF	85.03	0	0
PHWR SF	17.20	17.20	17.20
FR SF	0	0	0
Total SF	102.23	17.20	17.20
Pu	1.23	0.70	0.87
MA	0.13	0.12	0.11
FP	5.28	5.16	5.16
U	95.59	16.08	16.08
Recovered U	-	72.41	72.60



Existing reactors

Reactors near retiremnt[LWR]	0
Reactors under constr[LWR]	2.46
Under constr need fuel[LWR]	1.62
Reactors under lincen[LWR]	0
Fresh Reactors[LWR]	12

Times, yr

Start reprocess[LWR]	2200
Enrichment time[LWR]	1
Fabrication time[LWR]	2
Reprocess time[LWR]	0.5
Spent fuel storage time[LWR]	5

Initial material amounts, kt

Spent fuel[LWR,Core]	2.647
Spent fuel storage[LWR,Core]	0

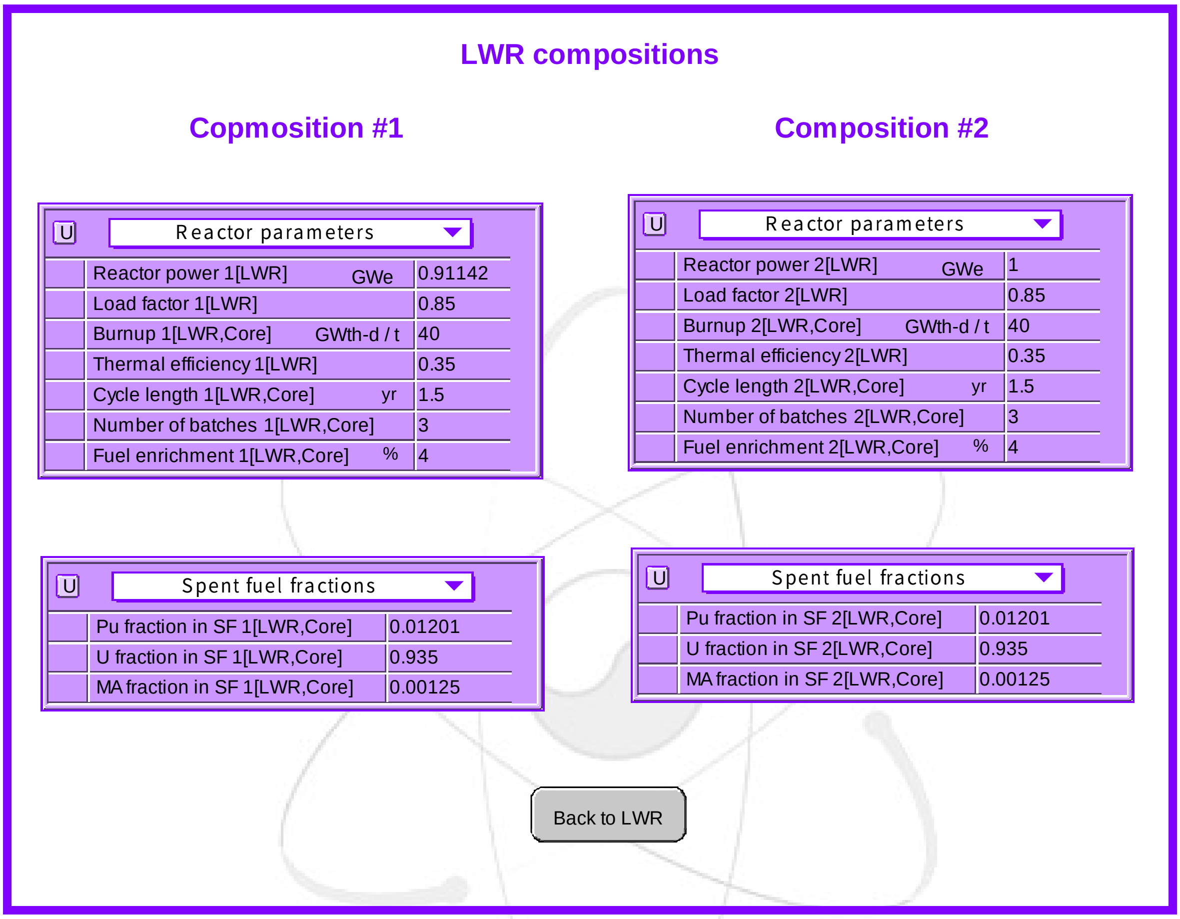
Reprocessing plant

Rep plant capacity[LWR] ktHM / y	1

Type of Reprocessing

- ☐ PUREX[LWR]
- ☑ APUREX[LWR]
- ☐ PYRO[LWR]

Fig. 1 PWR Input Data for DYMOND



LWR compositions

Copmosition #1

Reactor parameters

Reactor power 1[LWR]	GWe	0.91142
Load factor 1[LWR]		0.85
Burnup 1[LWR,Core]	GWth-d / t	40
Thermal efficiency 1[LWR]		0.35
Cycle length 1[LWR,Core]	yr	1.5
Number of batches 1[LWR,Core]		3
Fuel enrichment 1[LWR,Core]	%	4

Spent fuel fractions

Pu fraction in SF 1[LWR,Core]	0.01201
U fraction in SF 1[LWR,Core]	0.935
MA fraction in SF 1[LWR,Core]	0.00125

Composition #2

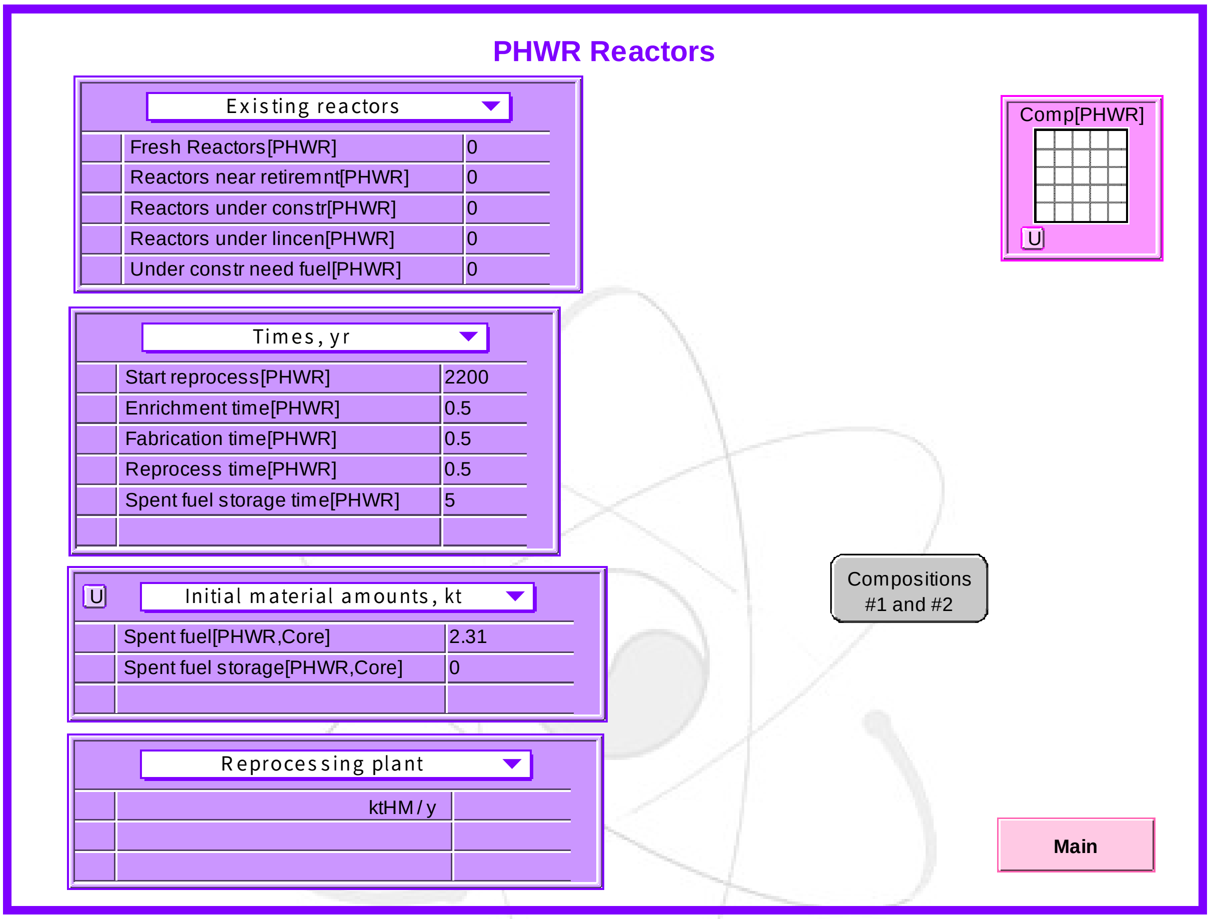
Reactor parameters

Reactor power 2[LWR]	GWe	1
Load factor 2[LWR]		0.85
Burnup 2[LWR,Core]	GWth-d / t	40
Thermal efficiency 2[LWR]		0.35
Cycle length 2[LWR,Core]	yr	1.5
Number of batches 2[LWR,Core]		3
Fuel enrichment 2[LWR,Core]	%	4

Spent fuel fractions

Pu fraction in SF 2[LWR,Core]	0.01201
U fraction in SF 2[LWR,Core]	0.935
MA fraction in SF 2[LWR,Core]	0.00125

Fig. 2 PWR Fuel Composition Data for DYMOND



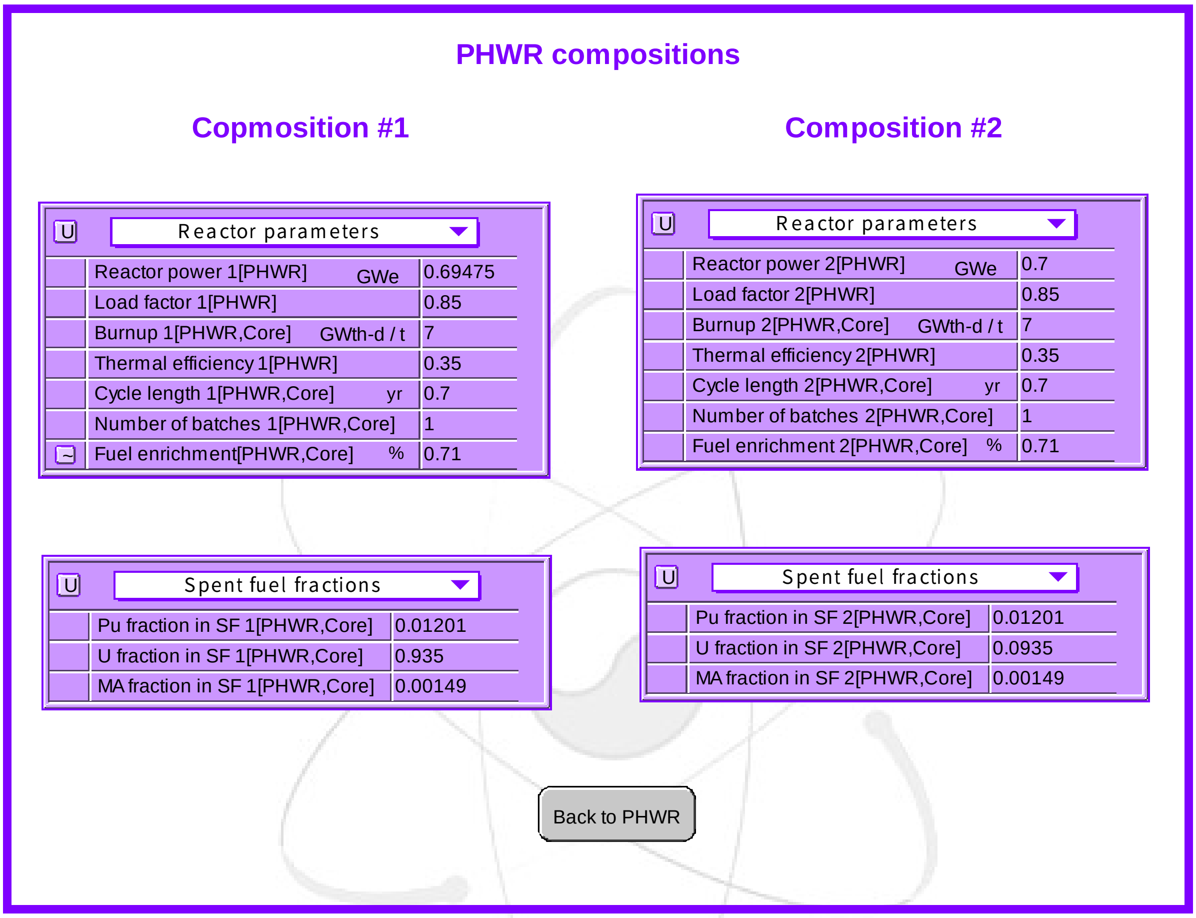
Existing reactors	
Fresh Reactors[PHWR]	0
Reactors near retiremnt[PHWR]	0
Reactors under constr[PHWR]	0
Reactors under lincen[PHWR]	0
Under constr need fuel[PHWR]	0

Times, yr	
Start reprocess[PHWR]	2200
Enrichment time[PHWR]	0.5
Fabrication time[PHWR]	0.5
Reprocess time[PHWR]	0.5
Spent fuel storage time[PHWR]	5

Initial material amounts, kt	
Spent fuel[PHWR,Core]	2.31
Spent fuel storage[PHWR,Core]	0

Reprocessing plant	
ktHM / y	

Fig. 3 PHWR Data for DYMOND



PHWR compositions

Copmosition #1

Reactor power 1[PHWR]	GWe	0.69475
Load factor 1[PHWR]		0.85
Burnup 1[PHWR,Core]	GWth-d / t	7
Thermal efficiency 1[PHWR]		0.35
Cycle length 1[PHWR,Core]	yr	0.7
Number of batches 1[PHWR,Core]		1
Fuel enrichment[PHWR,Core]	%	0.71

Pu fraction in SF 1[PHWR,Core]	0.01201
U fraction in SF 1[PHWR,Core]	0.935
MA fraction in SF 1[PHWR,Core]	0.00149

Composition #2

Reactor power 2[PHWR]	GWe	0.7
Load factor 2[PHWR]		0.85
Burnup 2[PHWR,Core]	GWth-d / t	7
Thermal efficiency 2[PHWR]		0.35
Cycle length 2[PHWR,Core]	yr	0.7
Number of batches 2[PHWR,Core]		1
Fuel enrichment 2[PHWR,Core]	%	0.71

Pu fraction in SF 2[PHWR,Core]	0.01201
U fraction in SF 2[PHWR,Core]	0.0935
MA fraction in SF 2[PHWR,Core]	0.00149

Fig. 4 PHWR Fuel Composition Data for DYMOND

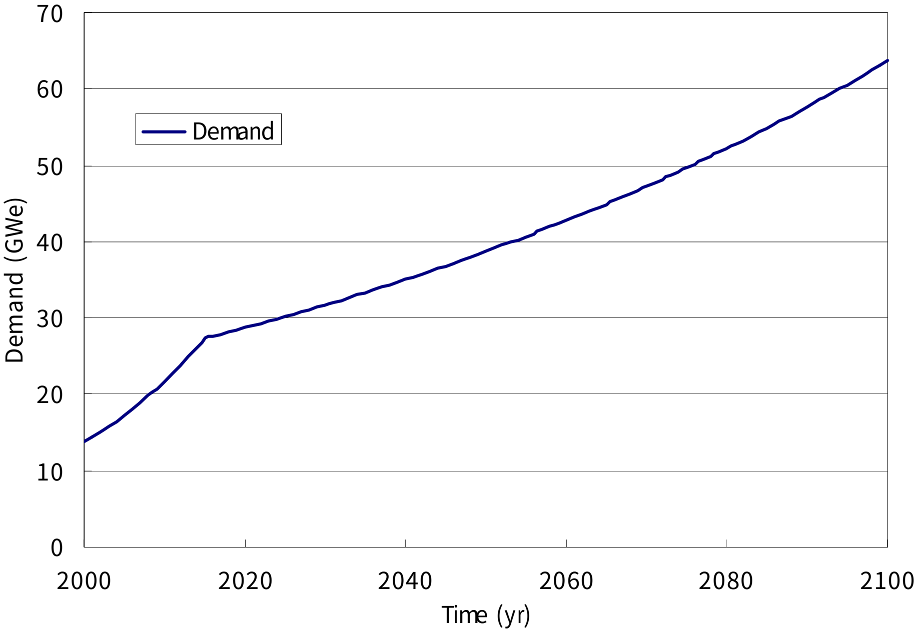


Fig. 5 Demand power scenario (Once-through)

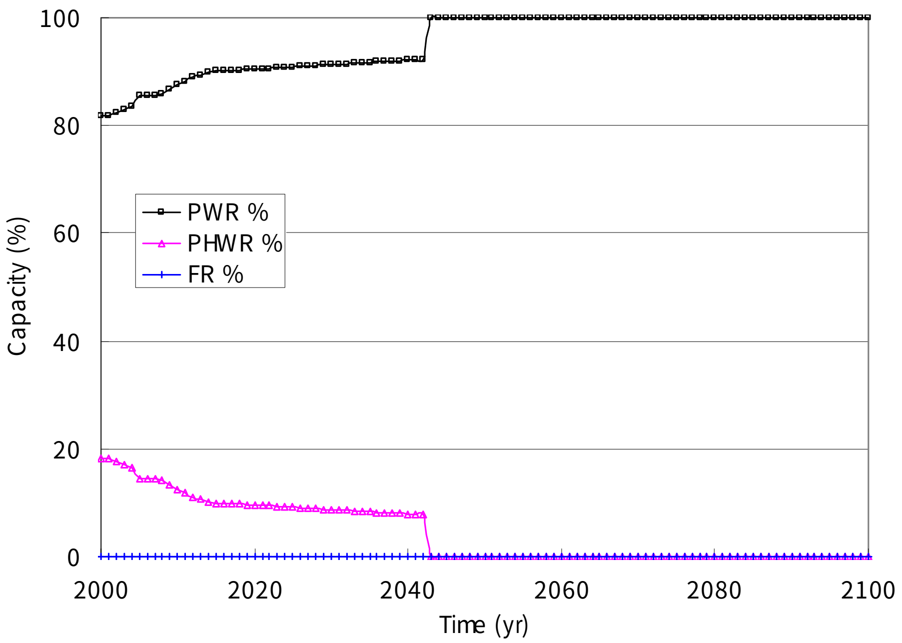


Fig. 6 Electricity Generation Fraction of Each Reactor Type (Once-through)

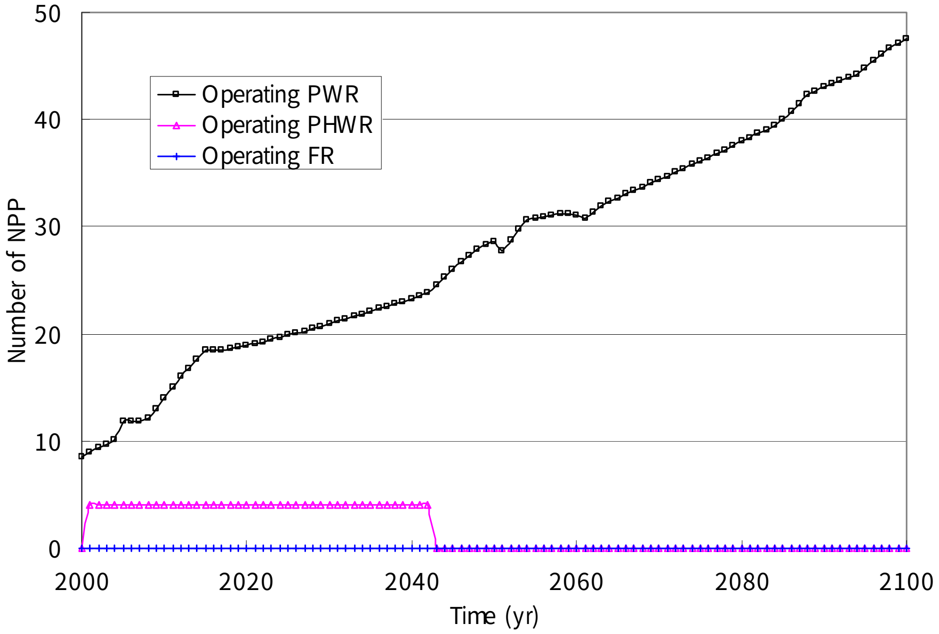


Fig. 7 Number of Operating Reactors (Once-through)

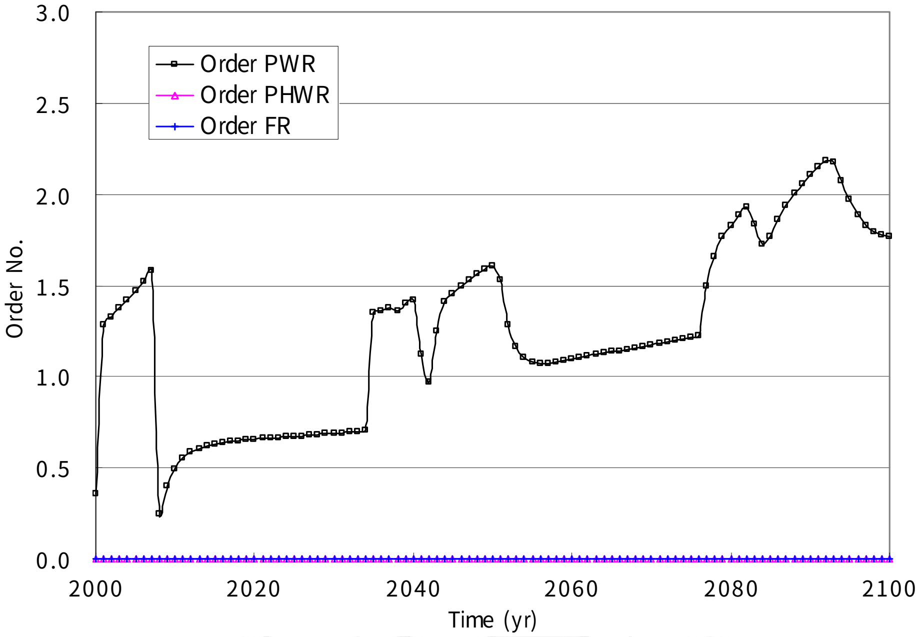


Fig. 8 Number of Reactor Orders (Once-through)

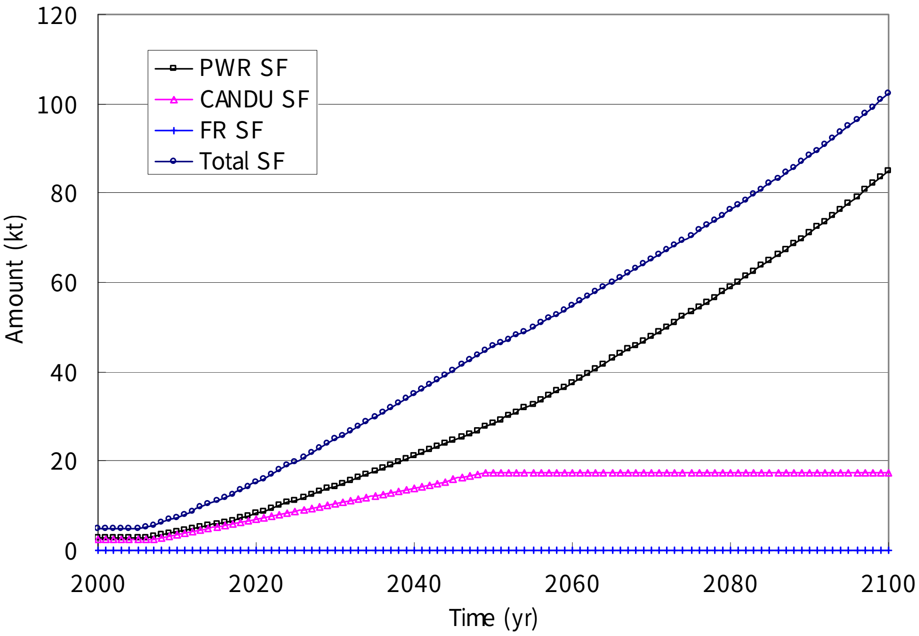


Fig. 9 Spent Fuel Inventory (Once-through)

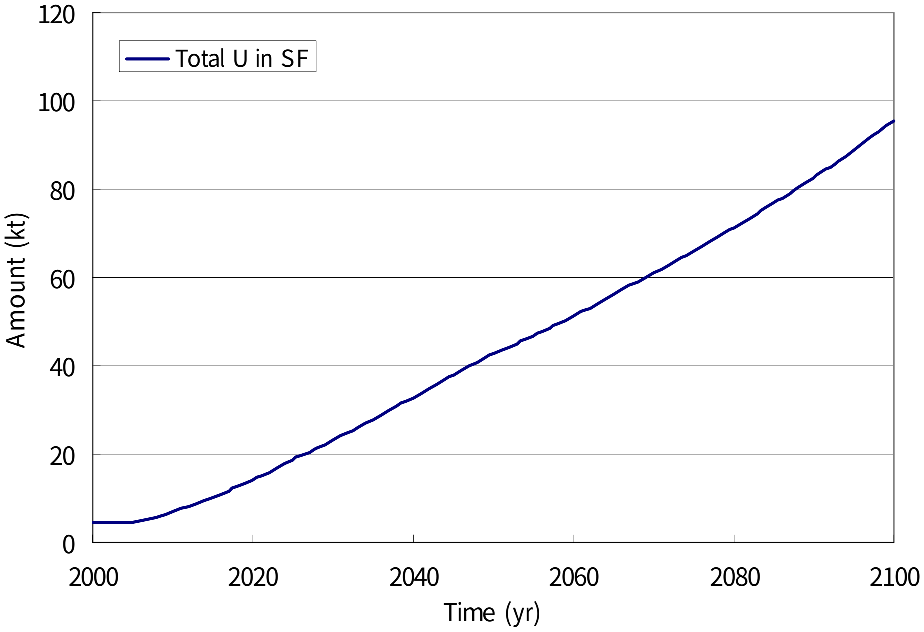


Fig. 10 Uranium Inventory (Once-through)

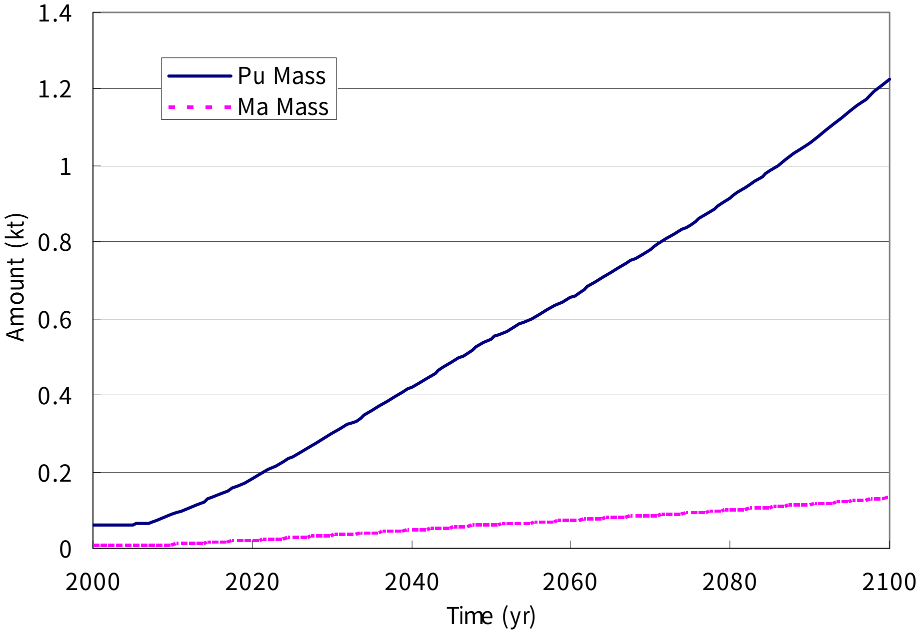


Fig. 11 Plutonium and Minor Actinide Inventory (Once-through)

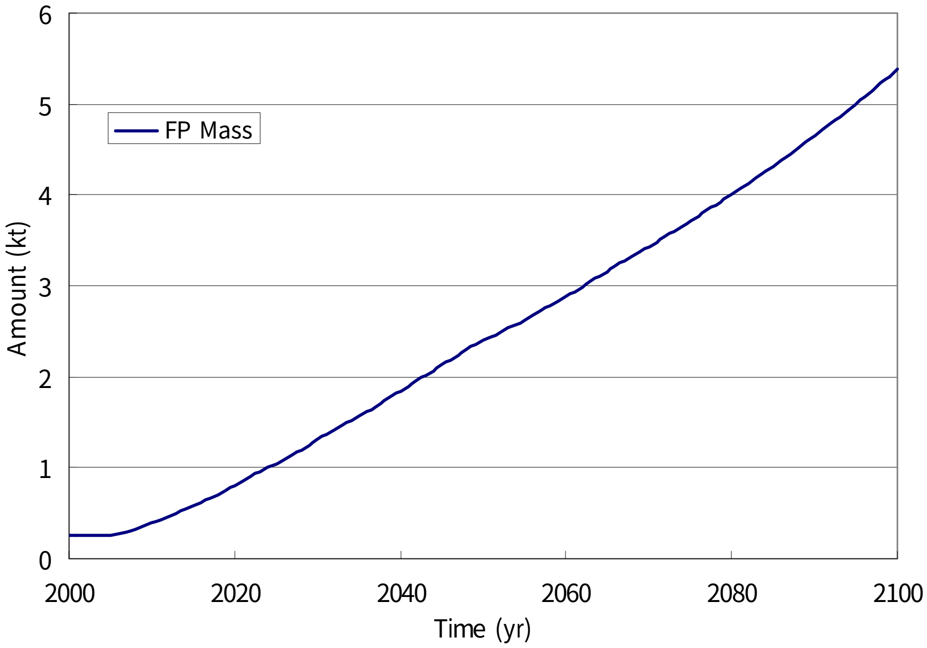


Fig. 12 Fission Products Inventory (Once-through)

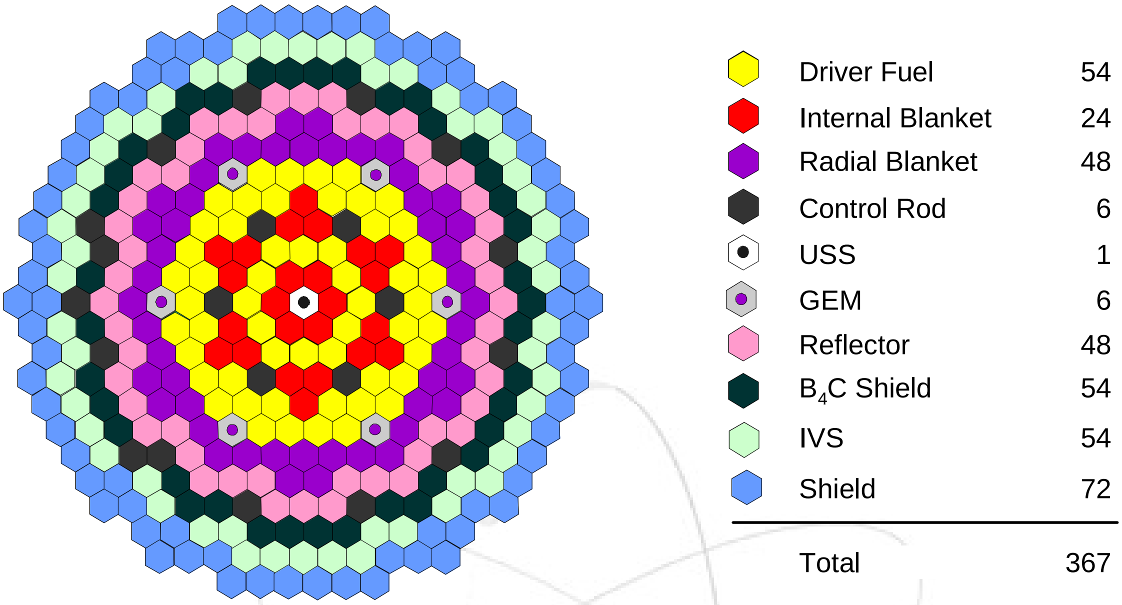


Fig. 13 KALIMER-150 Breakeven Core Layout

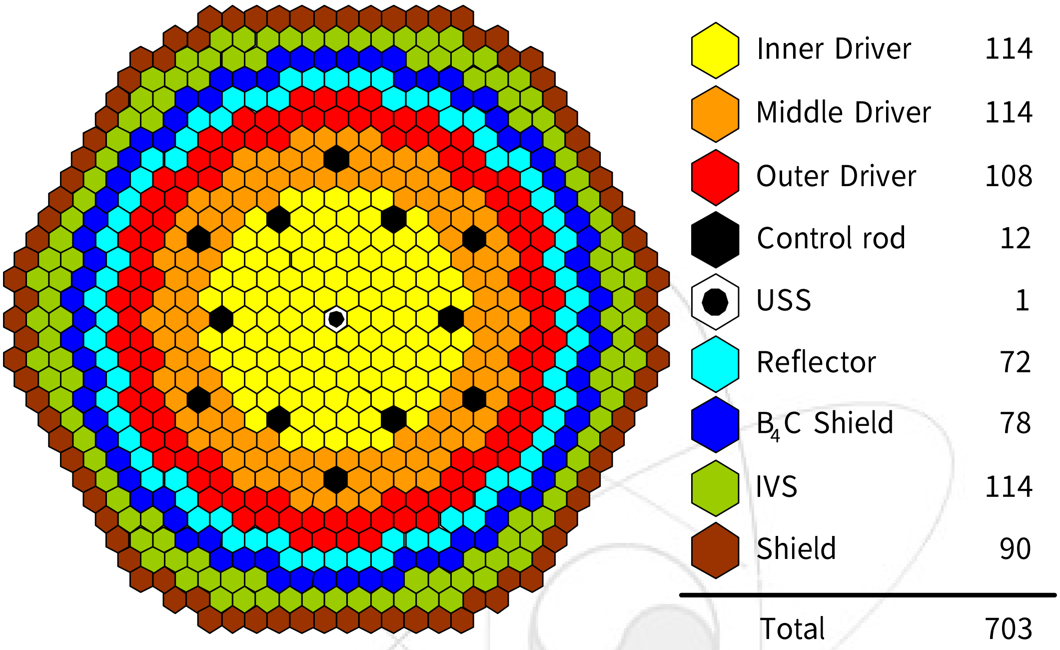
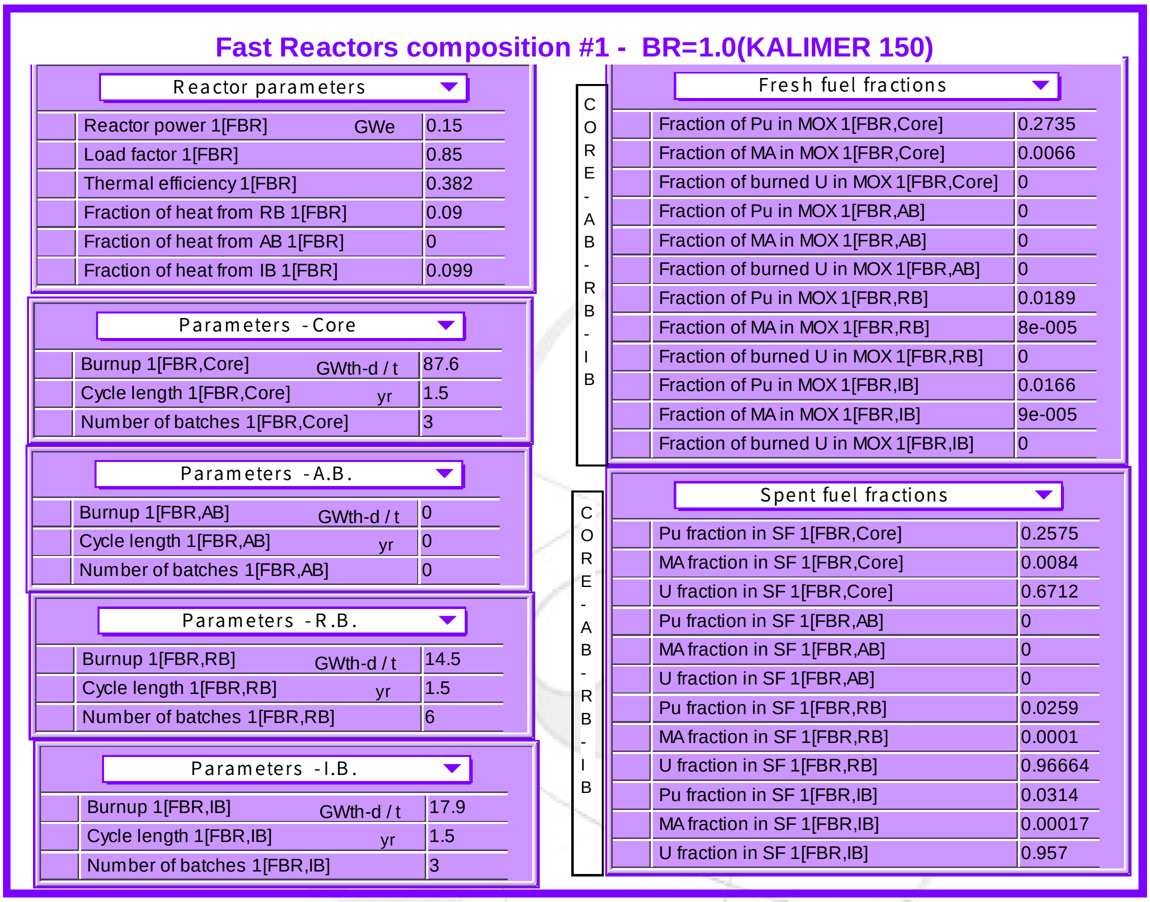


Fig. 14 KALIMER-600 Breakeven Core Layout



Fast Reactors composition #1 - BR=1.0(KALIMER 150)

Reactor parameters

Reactor power 1[FBR]	GWe	0.15
Load factor 1[FBR]		0.85
Thermal efficiency 1[FBR]		0.382
Fraction of heat from RB 1[FBR]		0.09
Fraction of heat from AB 1[FBR]		0
Fraction of heat from IB 1[FBR]		0.099

Parameters - Core

Burnup 1[FBR,Core]	GWth-d / t	87.6
Cycle length 1[FBR,Core]	yr	1.5
Number of batches 1[FBR,Core]		3

Parameters - A.B.

Burnup 1[FBR,AB]	GWth-d / t	0
Cycle length 1[FBR,AB]	yr	0
Number of batches 1[FBR,AB]		0

Parameters - R.B.

Burnup 1[FBR,RB]	GWth-d / t	14.5
Cycle length 1[FBR,RB]	yr	1.5
Number of batches 1[FBR,RB]		6

Parameters - I.B.

Burnup 1[FBR,IB]	GWth-d / t	17.9
Cycle length 1[FBR,IB]	yr	1.5
Number of batches 1[FBR,IB]		3

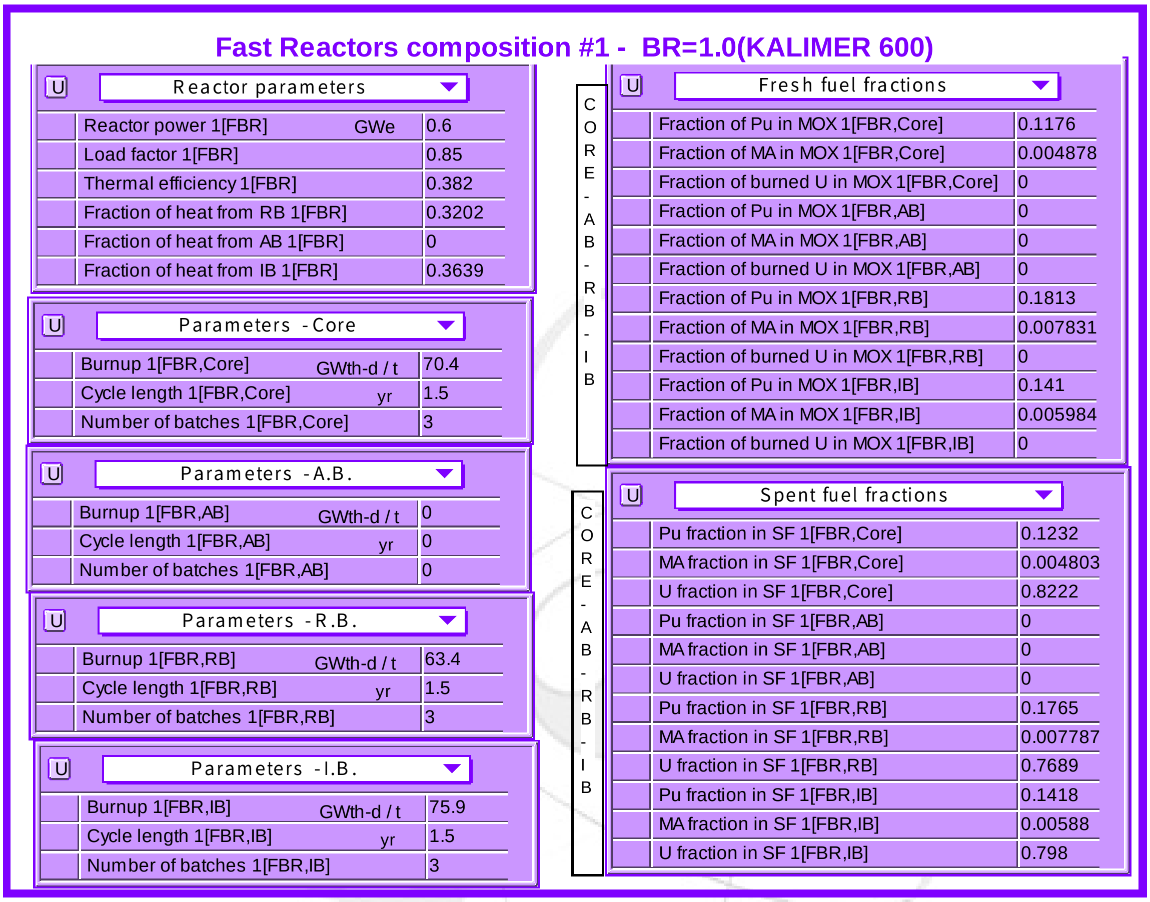
Fresh fuel fractions

Fraction of Pu in MOX 1[FBR,Core]	0.2735
Fraction of MA in MOX 1[FBR,Core]	0.0066
Fraction of burned U in MOX 1[FBR,Core]	0
Fraction of Pu in MOX 1[FBR,AB]	0
Fraction of MA in MOX 1[FBR,AB]	0
Fraction of burned U in MOX 1[FBR,AB]	0
Fraction of Pu in MOX 1[FBR,RB]	0.0189
Fraction of MA in MOX 1[FBR,RB]	8e-005
Fraction of burned U in MOX 1[FBR,RB]	0
Fraction of Pu in MOX 1[FBR,IB]	0.0166
Fraction of MA in MOX 1[FBR,IB]	9e-005
Fraction of burned U in MOX 1[FBR,IB]	0

Spent fuel fractions

Pu fraction in SF 1[FBR,Core]	0.2575
MA fraction in SF 1[FBR,Core]	0.0084
U fraction in SF 1[FBR,Core]	0.6712
Pu fraction in SF 1[FBR,AB]	0
MA fraction in SF 1[FBR,AB]	0
U fraction in SF 1[FBR,AB]	0
Pu fraction in SF 1[FBR,RB]	0.0259
MA fraction in SF 1[FBR,RB]	0.0001
U fraction in SF 1[FBR,RB]	0.96664
Pu fraction in SF 1[FBR,IB]	0.0314
MA fraction in SF 1[FBR,IB]	0.00017
U fraction in SF 1[FBR,IB]	0.957

Fig. 15 KALIMER-150 Fuel Composition Data for DYMOND



Fast Reactors composition #1 - BR=1.0(KALIMER 600)

Reactor parameters

Reactor power 1[FBR]	GWe	0.6
Load factor 1[FBR]		0.85
Thermal efficiency 1[FBR]		0.382
Fraction of heat from RB 1[FBR]		0.3202
Fraction of heat from AB 1[FBR]		0
Fraction of heat from IB 1[FBR]		0.3639

Parameters - Core

Burnup 1[FBR,Core]	GWth-d / t	70.4
Cycle length 1[FBR,Core]	yr	1.5
Number of batches 1[FBR,Core]		3

Parameters - A.B.

Burnup 1[FBR,AB]	GWth-d / t	0
Cycle length 1[FBR,AB]	yr	0
Number of batches 1[FBR,AB]		0

Parameters - R.B.

Burnup 1[FBR,RB]	GWth-d / t	63.4
Cycle length 1[FBR,RB]	yr	1.5
Number of batches 1[FBR,RB]		3

Parameters - I.B.

Burnup 1[FBR,IB]	GWth-d / t	75.9
Cycle length 1[FBR,IB]	yr	1.5
Number of batches 1[FBR,IB]		3

Fresh fuel fractions

Fraction of Pu in MOX 1[FBR,Core]	0.1176
Fraction of MA in MOX 1[FBR,Core]	0.004878
Fraction of burned U in MOX 1[FBR,Core]	0
Fraction of Pu in MOX 1[FBR,AB]	0
Fraction of MA in MOX 1[FBR,AB]	0
Fraction of burned U in MOX 1[FBR,AB]	0
Fraction of Pu in MOX 1[FBR,RB]	0.1813
Fraction of MA in MOX 1[FBR,RB]	0.007831
Fraction of burned U in MOX 1[FBR,RB]	0
Fraction of Pu in MOX 1[FBR,IB]	0.141
Fraction of MA in MOX 1[FBR,IB]	0.005984
Fraction of burned U in MOX 1[FBR,IB]	0

Spent fuel fractions

Pu fraction in SF 1[FBR,Core]	0.1232
MA fraction in SF 1[FBR,Core]	0.004803
U fraction in SF 1[FBR,Core]	0.8222
Pu fraction in SF 1[FBR,AB]	0
MA fraction in SF 1[FBR,AB]	0
U fraction in SF 1[FBR,AB]	0
Pu fraction in SF 1[FBR,RB]	0.1765
MA fraction in SF 1[FBR,RB]	0.007787
U fraction in SF 1[FBR,RB]	0.7689
Pu fraction in SF 1[FBR,IB]	0.1418
MA fraction in SF 1[FBR,IB]	0.00588
U fraction in SF 1[FBR,IB]	0.798

Fig. 16 KALIMER-600 Fuel Composition Data for DYMOND

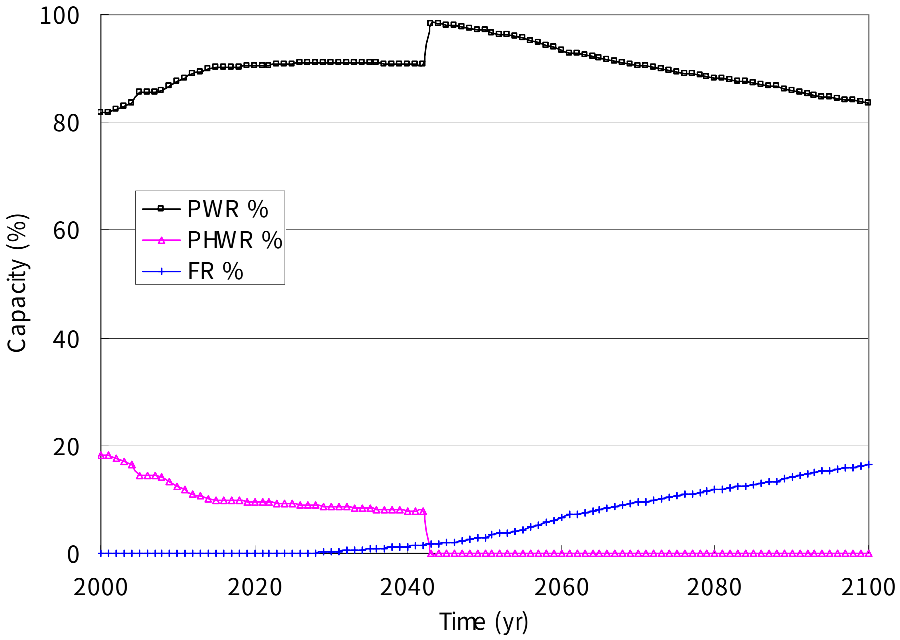


Fig. 17 Electricity Generation Fraction of Each Reactor Type (KALIMER-150)

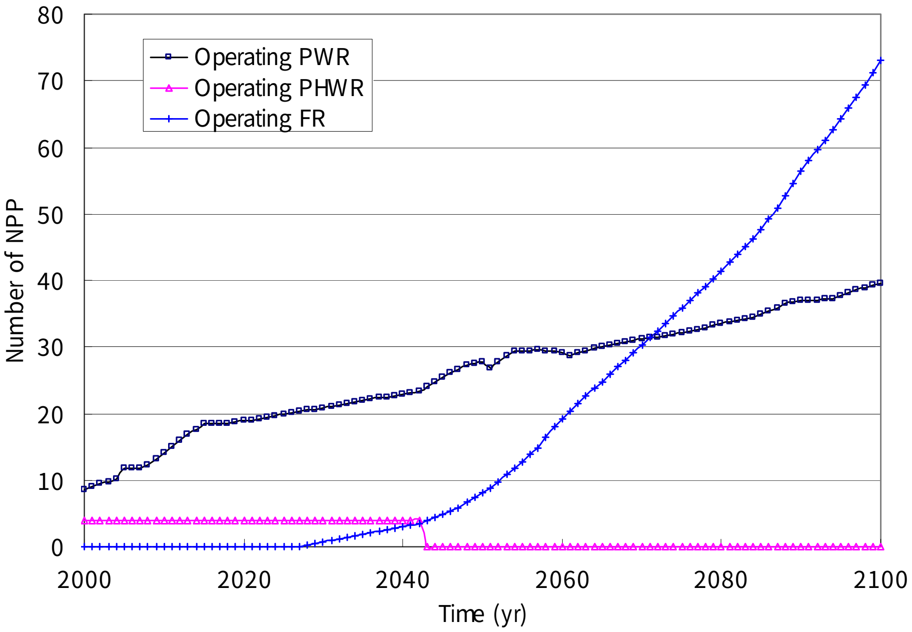


Fig. 18 Number of Operating Reactors (KALIMER-150)

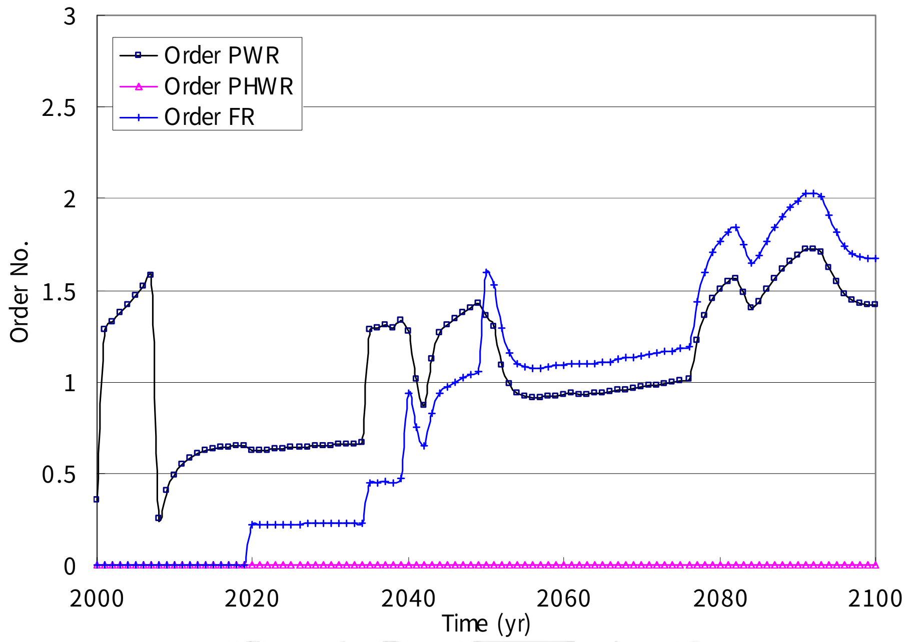


Fig. 19 Number of Reactor Orders (KALIMER-150)

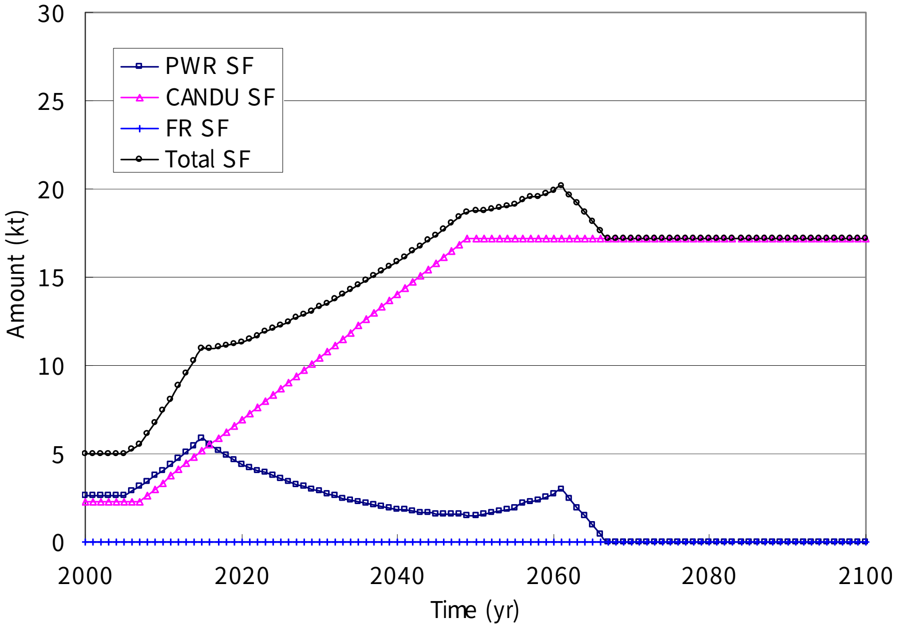


Fig. 20 Spent Fuel Inventory (KALIMER-150)

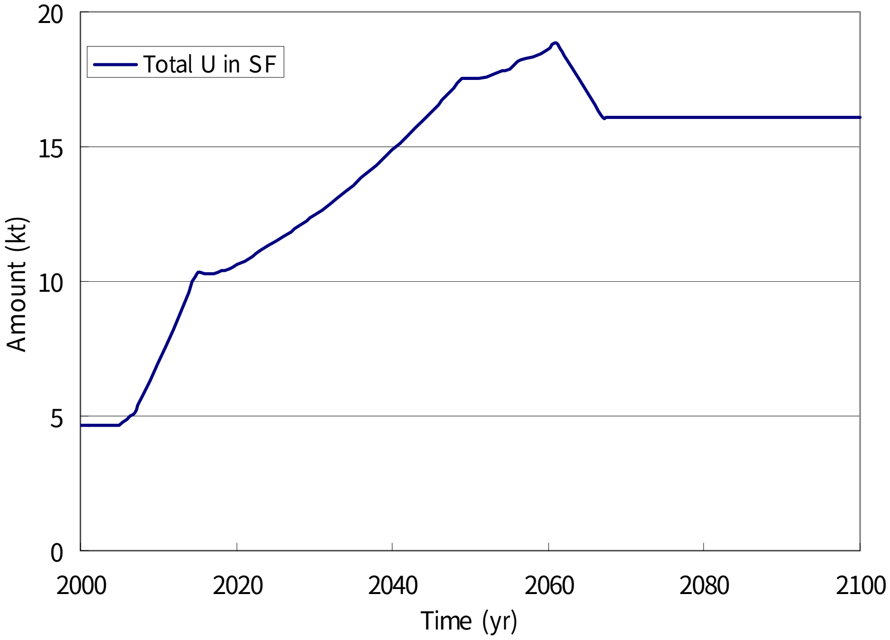


Fig. 21 Uranium Inventory (KALIMER-150)

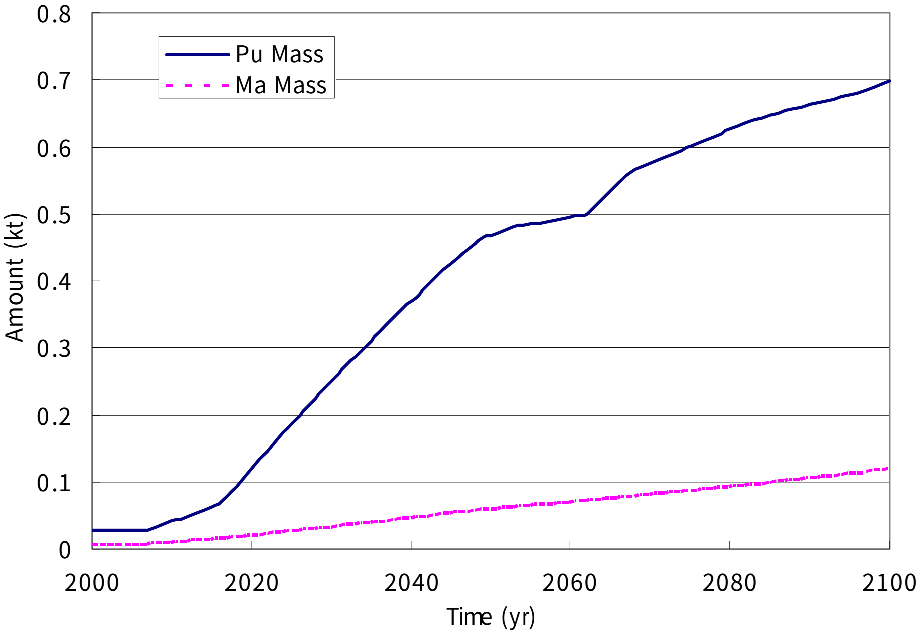


Fig. 22 Plutonium and Minor Actinide Inventory (KALIMER-150)

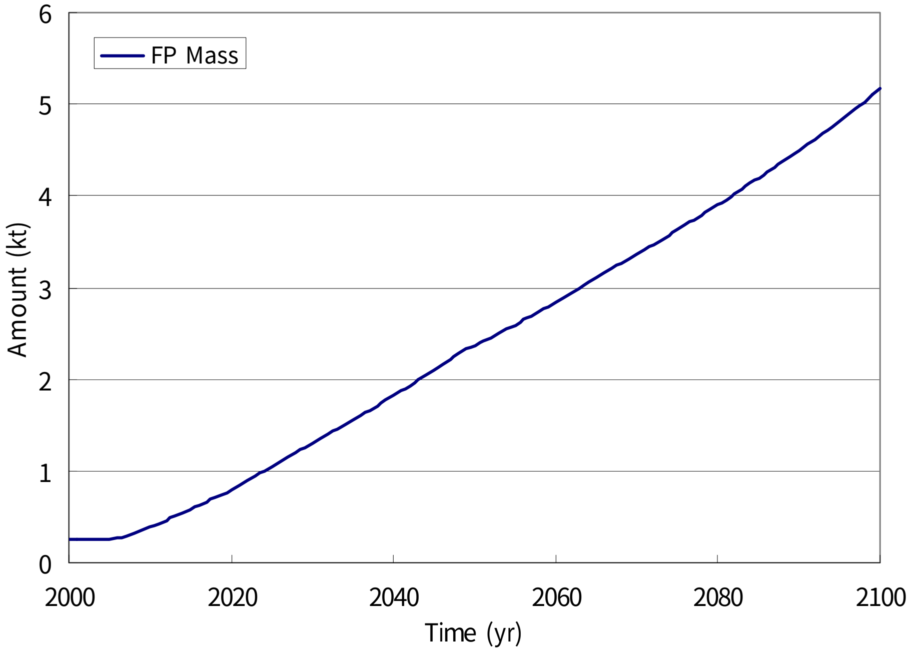


Fig. 23 Fission Products Inventory (KALIMER-150)

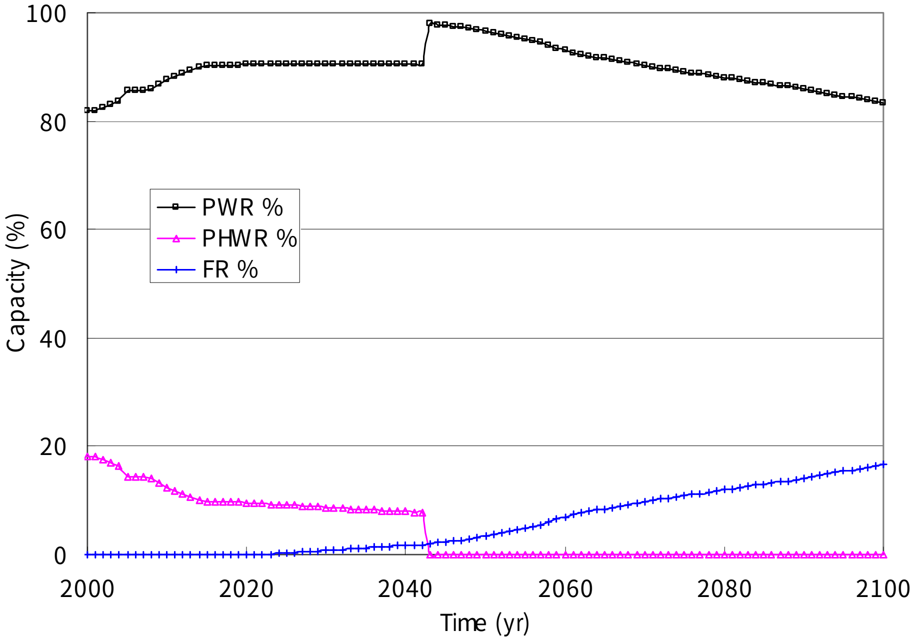


Fig. 24 Electricity Generation Fraction of Each Reactor Type (KALIMER-600)

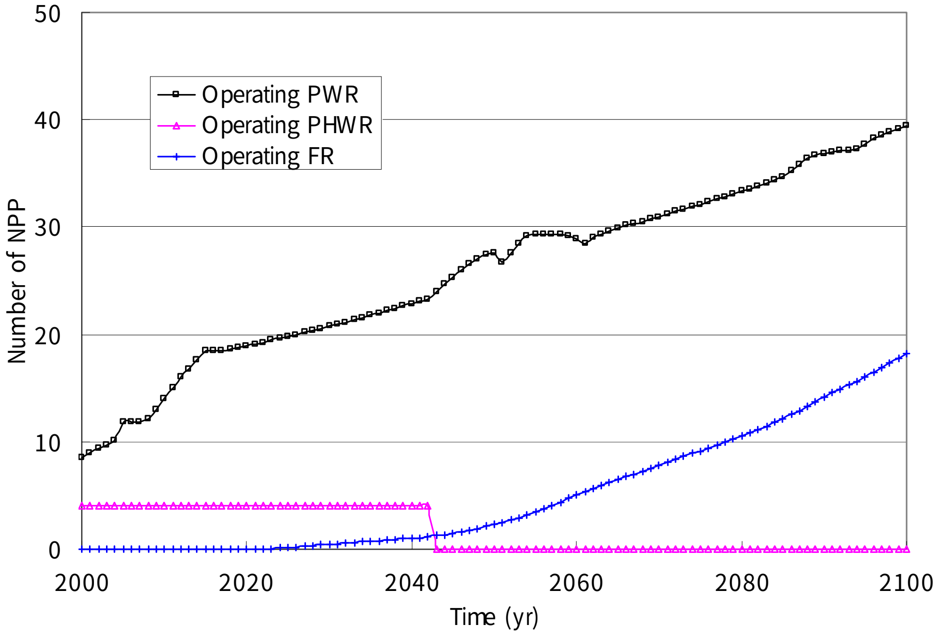


Fig. 25 Number of Operating Reactors (KALIMER-600)

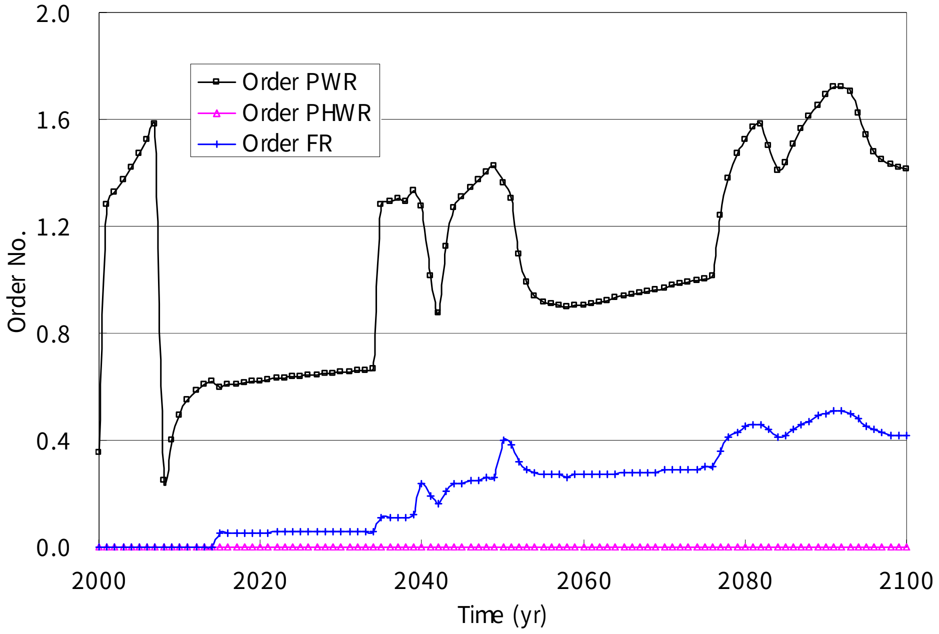


Fig. 26 Number of Reactor Orders (KALIMER-600)

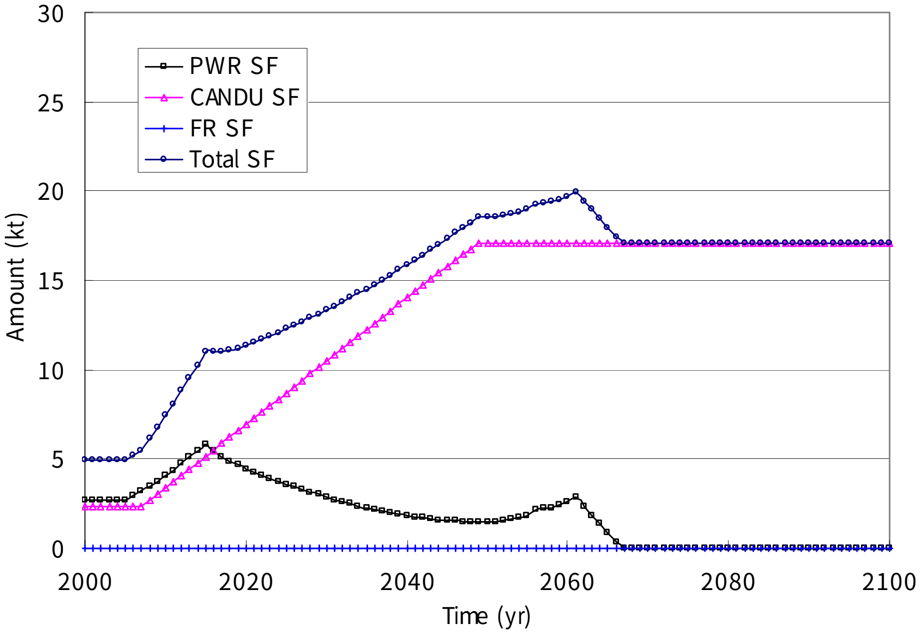


Fig. 27 Spent Fuel Inventory (KALIMER-600)

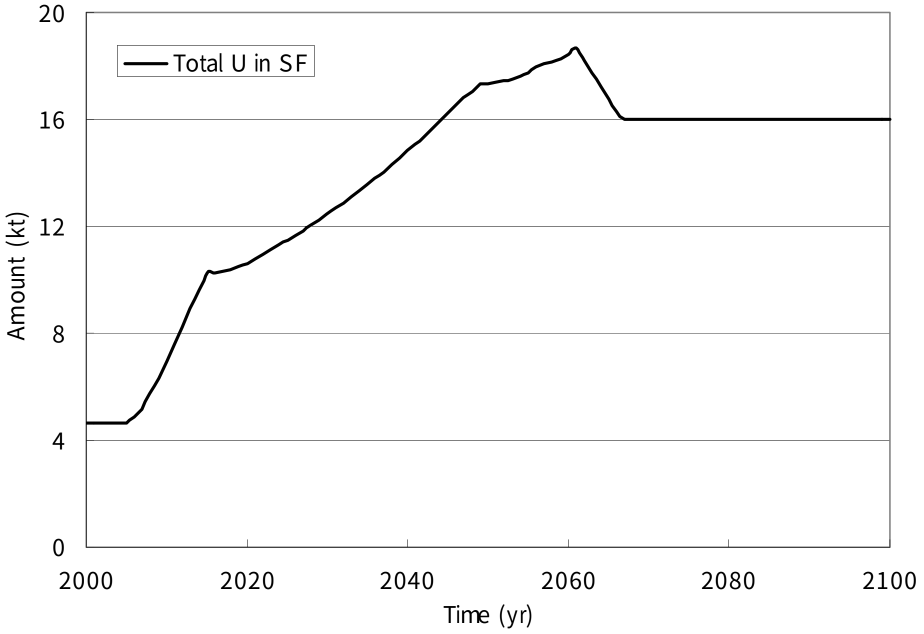


Fig. 28 Uranium Inventory (KALIMER-600)

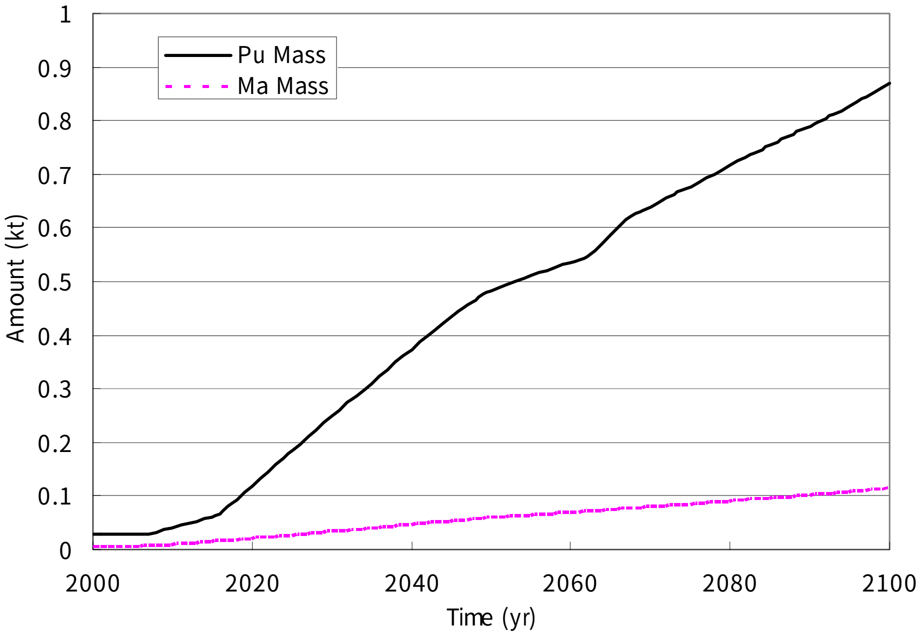


Fig. 29 Plutonium and Minor Actinide Inventory (KALIMER-600)

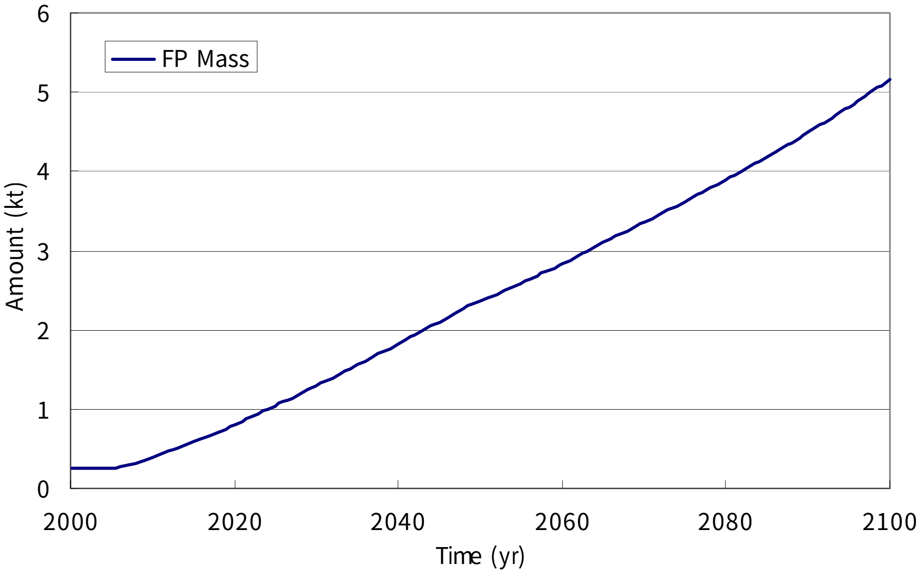


Fig. 30 Fission Products Inventory (KALIMER-600)

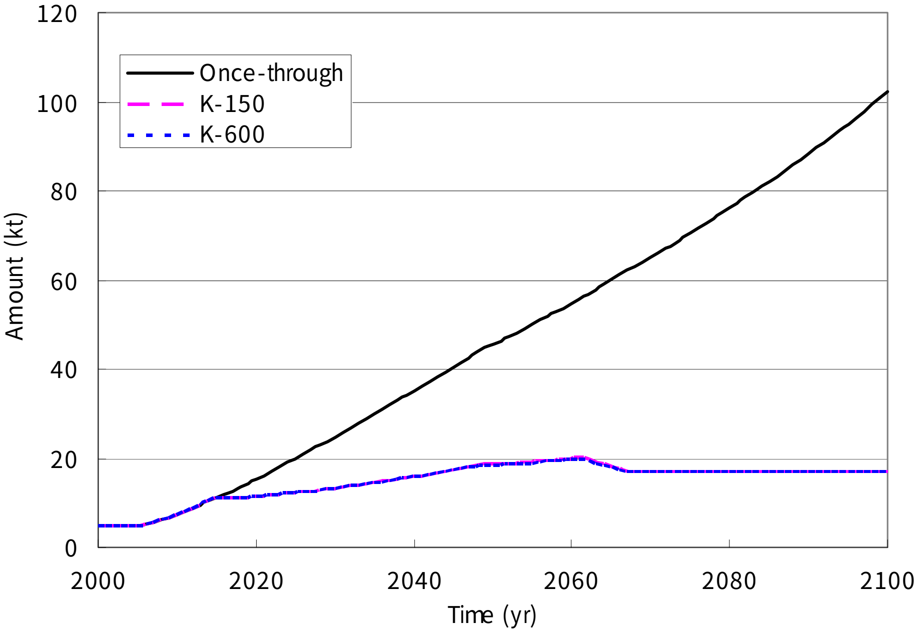


Fig. 31 Comparison of Spent Fuel Accumulation

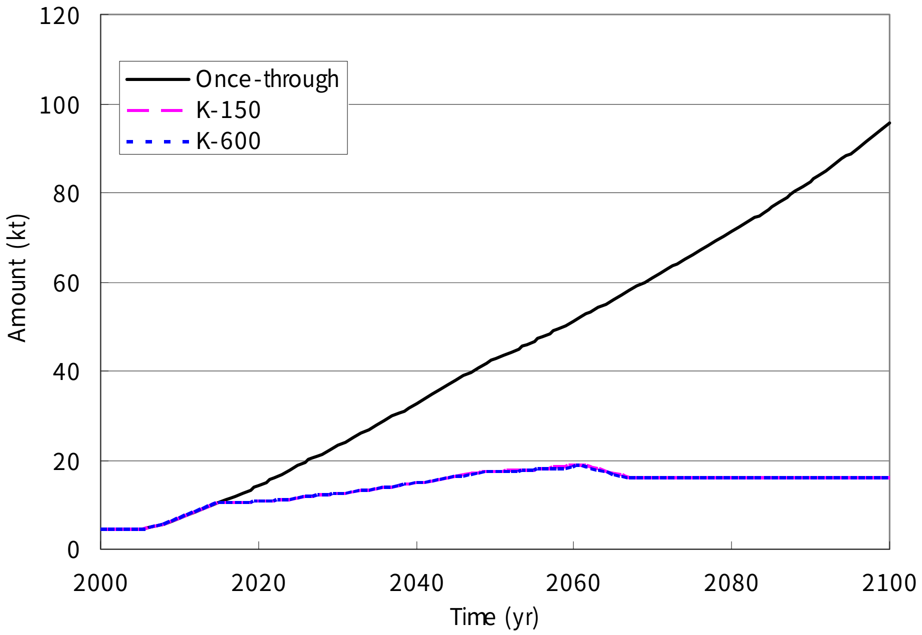


Fig. 32 Comparison of Uranium Accumulation

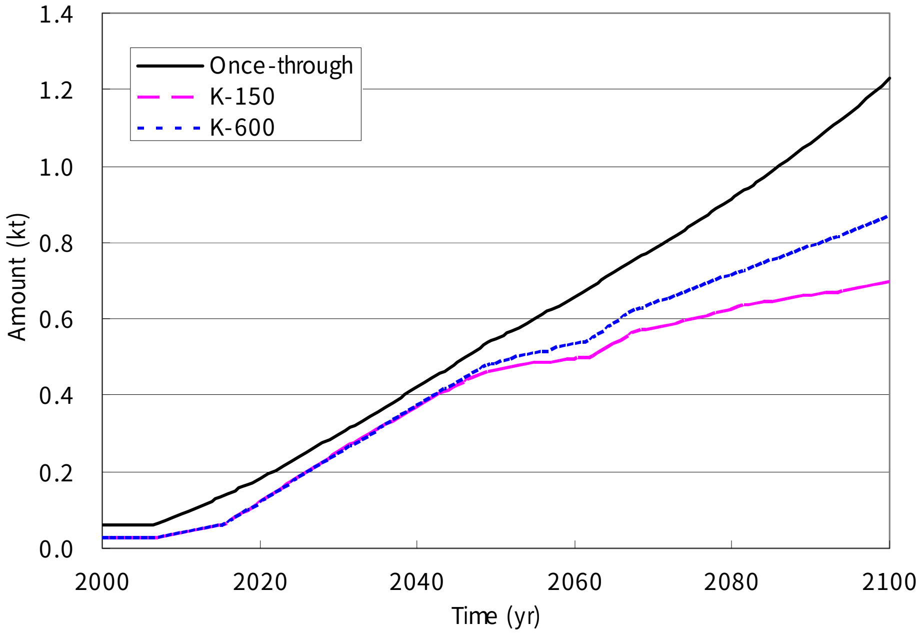


Fig. 33 Comparison of Plutonium Accumulation

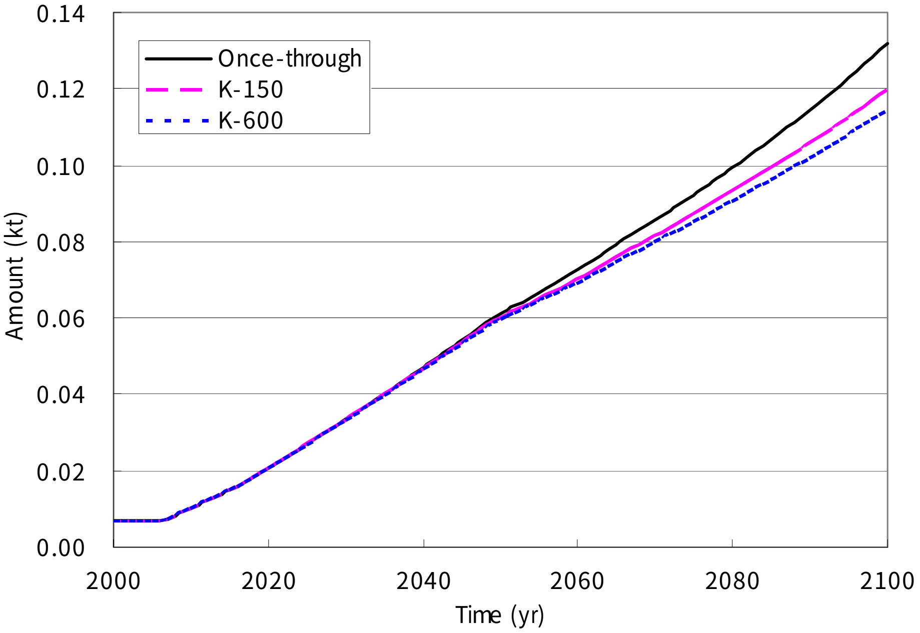


Fig. 34 Comparison of Minor Actinides Accumulation

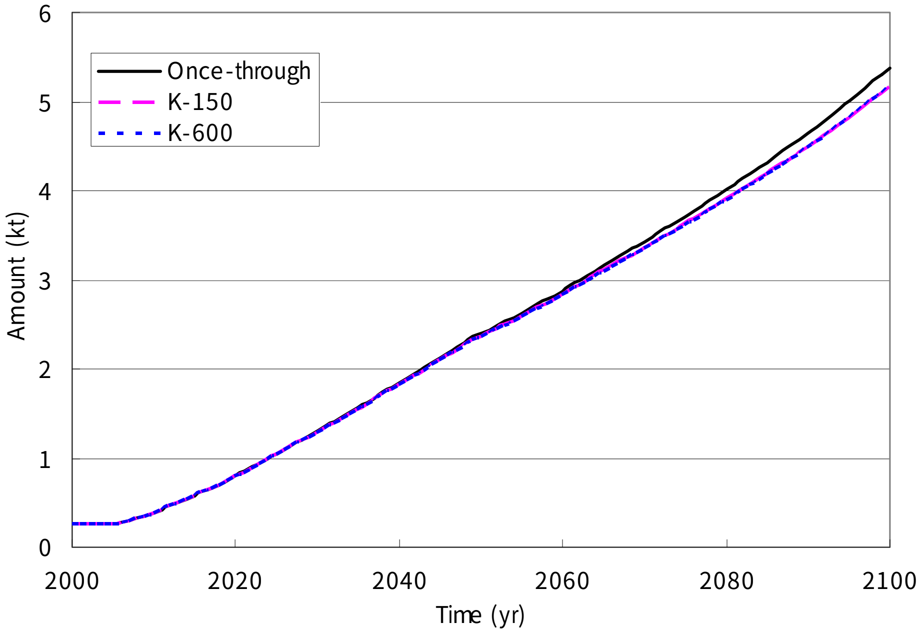


Fig. 35 Comparison of Fission Products Accumulation

서지정보양식

수행기관보고서번호	위탁기관보고서번호	표준보고서번호	INIS 주제코드
KAERI/TR-2859/2004			

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연구자 및 부서명	

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비밀여부	공개( ), 대외비( ), __ 급비밀, 소내만 공개 (O)	보고서종류	기술보고서
연구위탁기관		계약 번호	

초록 (15-20줄내외)

한국 고속로 주기를 동적 분석 방법론을 사용하여 분석하였다. 비순환 주기의 모형화를 위해 2015 년까지의 원전 건설 계획을 고려하였으며, 2016 년 이후에는 원자력 요구량 증가율을 1%로 가정하였다. 비순환 주기 모형화 후 한국형 고속로인 KALIMER 주기를 모형화하였다. 본 계산에서는 KALIMER-150 및 KALIMER-600 원자로를 고려하여 사용후 핵연료 양 및 이에 따른 플루토늄과 minor actinide 및 핵분열 생성물 양을 예측하고 비순환 주기와 비교 분석 하였다.

비순환 주기에 대한 분석 결과, 2100 년도에는 원자력 요구량이약 64GWe 까지 증가하며, 이에 따라 사용후 핵연료 양도 약 102 kt 에 이를 것으로 예측되었다. KALIMER 원자로 주기를 도입하면 사용후 핵연료 양을 약 80% 감소시킬 수 있는 것으로 나타났으며, 또한, KALIMER 와 같은 고속도 주기는사용후 핵연료 처분장 설계시 중여한 인자인 minor actinide 및 핵분열 생성물의 양을 감소시키지는 못하는 것으로 나타났다. 따라서, 향후 minor actinide 및 핵분열 생성물을 추가로 감소시킬 수 있는 연소로 도입이 고려될 수 있다.

주제명키워드 (10단어내외)	한국 고속로 주기, 동적 분석 방법, 비순환 주기, 고속로, 사용후 핵연료 , 플루토늄, minor actinide, 핵분열생성물

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Researcher and Department	

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Abstract (15-20 Lines)

The Korean nuclear fuel cycle scenario was analyzed by the dynamic analysis method, including Pressurized Water Reactor (PWR), Canadian Deuterium Uranium (CANDU) and fast reactor systems. For the once-through fuel cycle model, the existing nuclear power plant construction plan was considered up to 2016, while the nuclear demand growth rate from the year 2016 was assumed to be 1%. After setting up the once-through fuel cycle model, the Korea Advanced Liquid Metal Reactor (KALIMER) scenario was modeled to investigate the fuel cycle parameters. For the analysis of the fast reactor fuel cycle, both KAILMER-150 and KALIMER-600 reactors were considered. In this analysis, the spent fuel inventory as well as the amount of plutonium, minor actinides (MA) and fission products (FP) of the recycling fuel cycle was estimated and compared to that of the once-through fuel cycle.

Results of the once-through fuel cycle calculation showed that the demand grows up to 64 GWe and total amount of spent fuel would be ~102 kt in 2100. If the KALIMER scenario is implemented, the total spent fuel inventory can be reduced by ~80%. However it was found that the KALIMER scenario does not contribute to reduce the amount of MA and FP, which is important when designing a repository. For the further destruction of MA, an actinide burner can be considered in the future nuclear fuel cycle.

Subject Keywords (About 10 words)	Korean fast reactor cycle, dynamic analysis method, once-through cycle, fast reactor, spent fuel, plutonium, minor actinide, fission products